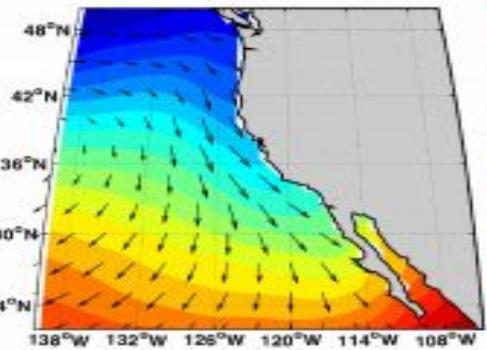
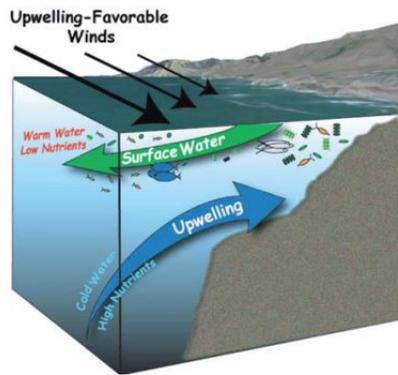


Importance of Winter Upwelling in the California Current Ecosystem

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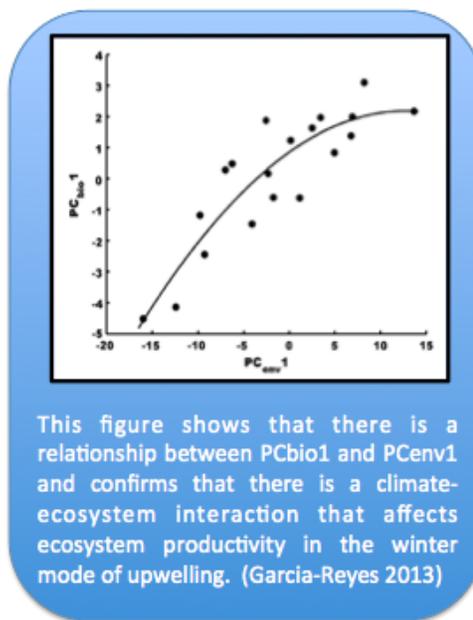
What is coastal upwelling? Coastal upwelling brings nutrient-rich water to the photic zone of the ocean. This fuels primary production and helps sustain large populations of pelagic fish and pelagic fish predators. Coastal upwelling is driven by steep gradients in sea level pressure which causes alongshore winds. These winds draw cold, nutrient-rich water to the surface through Ekman transport.



What are “modes of variability”? Research shows that there are two distinct, uncorrelated modes of upwelling, one representing the winter months (January–March) and one representing the summer months. Data from the Upwelling Index (UI) and from upwelling proxies such as sea surface temperature and regional wind buoys all corroborate these distinct upwelling modes. For most species, productivity was determined by the amount of upwelling in the winter upwelling mode.



Why is the winter upwelling mode so important to marine ecosystems? Winter upwelling is a key determinant of ecosystem productivity, though its magnitude seems insignificant compared to summer upwelling. Winter upwelling preconditions ecosystems by increasing primary production and thus increasing prey availability for many species prior to the spring/summer breeding season. This leads to healthier, more productive adult populations at the start of the breeding season and ultimately to greater ecosystem productivity.



What are the drivers of winter upwelling variability? The winter mode of upwelling correlates with ENSO, NOI, and NPH. However, the summer mode of upwelling does not clearly correlate with any environmental factor. Variability in upwelling-favorable winds in the California system is dominated by oceanic high pressure systems (OH), especially in the winter, and they are weakly influenced by continental thermal low pressure systems (CTL). A 600 year reconstruction of winter upwelling magnitude shows that variability in winter upwelling magnitude has risen since 1950.

There is an inverse relationship between marine ecosystem productivity (winter upwelling magnitude) and terrestrial tree growth (precipitation) because both are related to the sea level pressure over the North Pacific High (NPH). This correlation enabled the 600 year winter upwelling reconstruction.